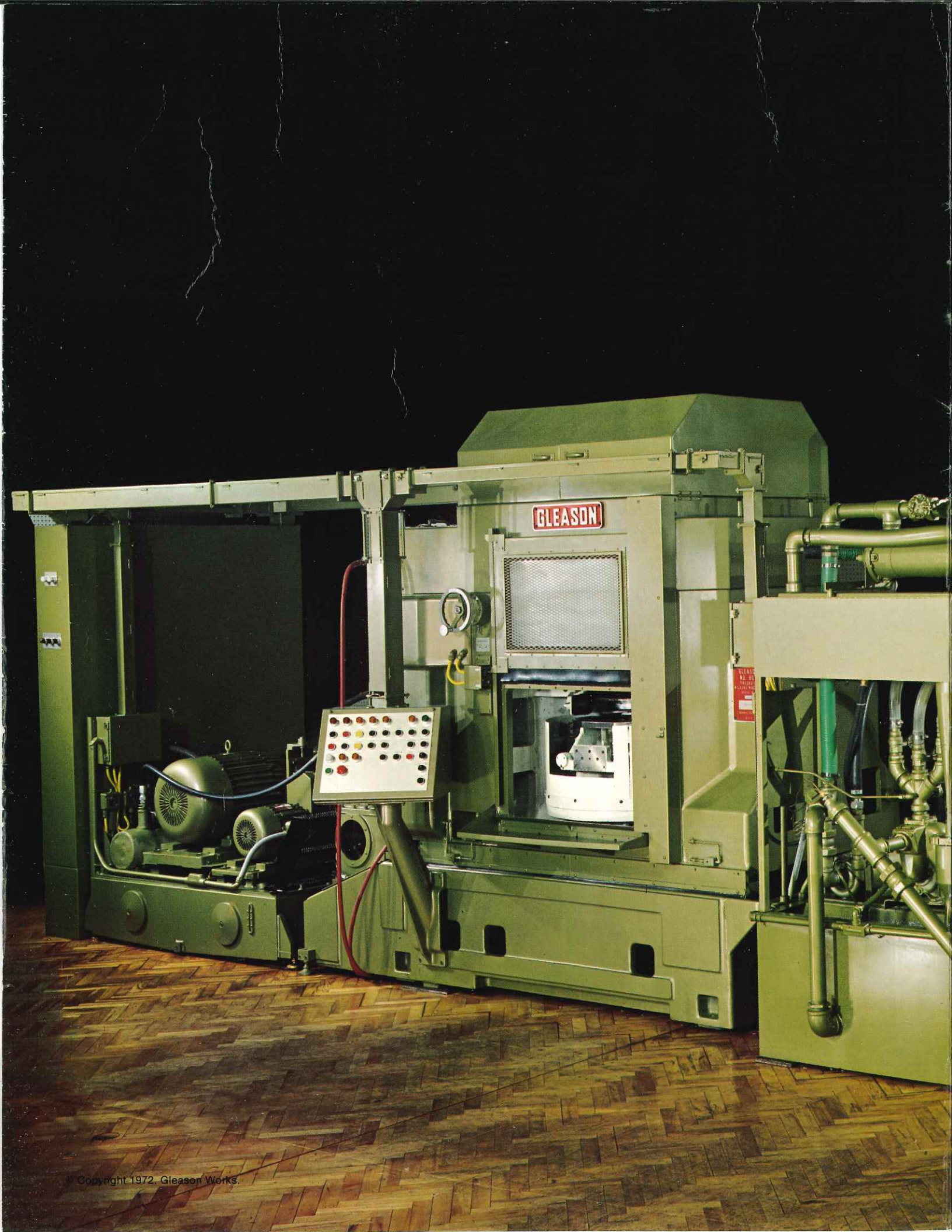
Gleason

No. 807 Trochoid Generating Milling Machine



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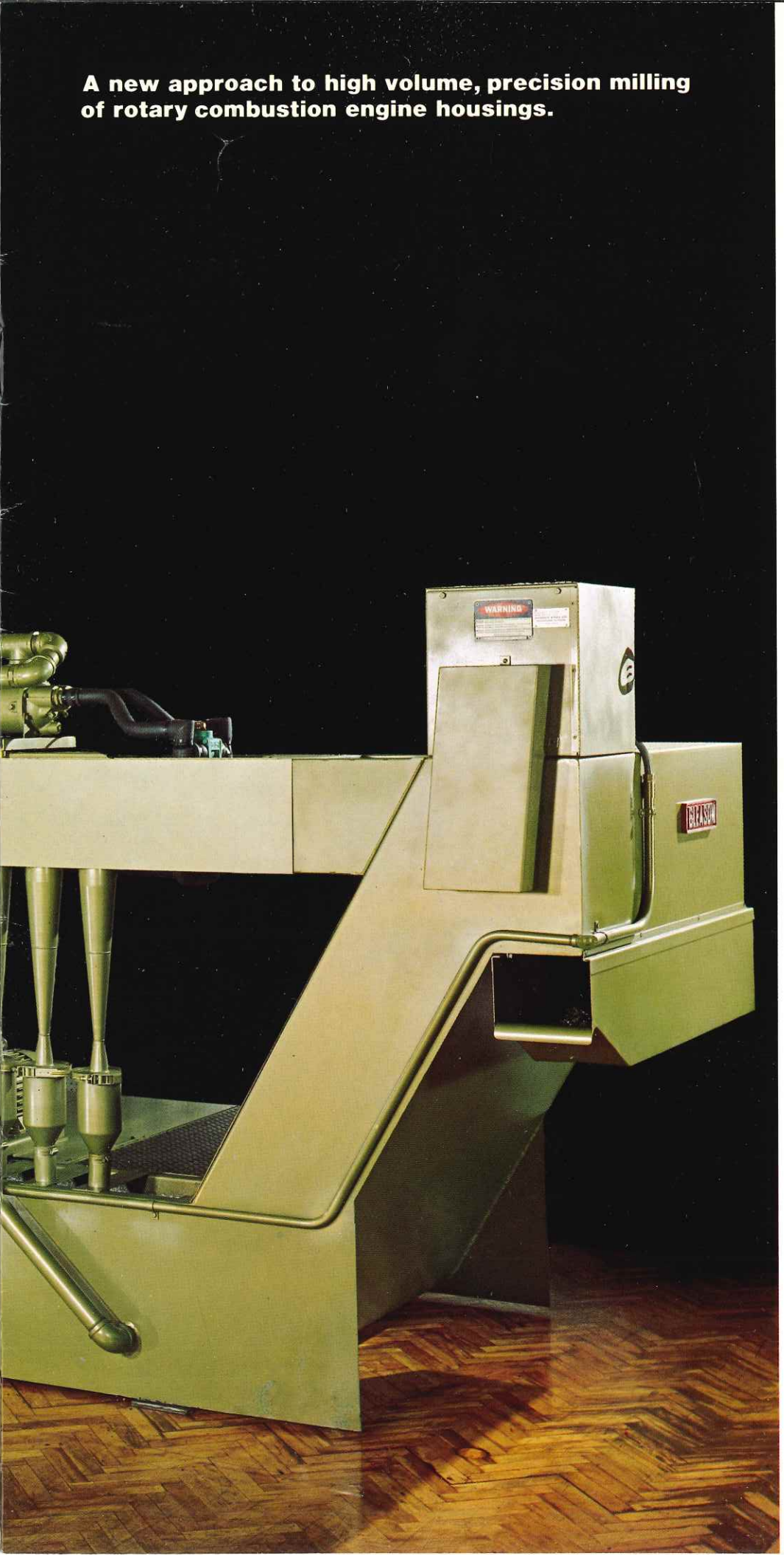
A new approach to high volume, precision milling of rotary combustion engine housings.



The Gleason No. 807 Trochoid Generating Milling Machine is a new concept for producing highly accurate trochoidal surfaces on a production basis.

Through unique kinematics, this machine generates the exact trochoid shape, using simple rotary motions. Changes in size are achieved with four simple machine settings. This permits easy setups, high production, minimum change-over requirements, and long, trouble-free operation. The No. 807 Milling Machine is designed to mill the bore of rotary engine housings up to 16″ major diameter, prior to coating or finish grinding. High production features include:

AUTOMATIC OPERATION

The operating sequence is fully automatic and the machine can be arranged for either manual or automatic load and unload. Standard features include automatic work positioning and clamping, automatic feed and pre-set cutting cycle.

GENERATING MOTION

Used to produce the trochoid shape, the generating principle requires only simple rotary motions that are controlled by pre-loaded, precision, anti-friction bearings. The trochoid shape will be the same from machine to machine since it depends only on machine settings and fixed gear ratios in the drive system.

DIRECT MACHINE SETTINGS

Adjustments in trochoid size are related to four basic parameters and are made by simple changes in machine settings.

HIGH PRODUCTION MILLING METHODS

Rugged, generating drive train assures fast metal removal and long-lasting accuracy; high volume coolant flow provides optimum chip removal.

VARIABLE WORKPIECE ROTATION RATE

Optimizes the surface speed of the work past the cutter at all positions around the trochoidal surface.

ADJUSTABLE CUTTER SPEED

Provides a means of obtaining optimum cutter speed conditions. Helps remove stock at the best rate, leaving the proper finish with the longest cutter life.

TROCHOID MODIFICATIONS

Changes in theoretical trochoid shape can be obtained by cam control.

TRANSFER LINE OPERATION

Can be adapted to transfer line operation to suit customer needs. Housings are readily accessible and oriented for easy handling.

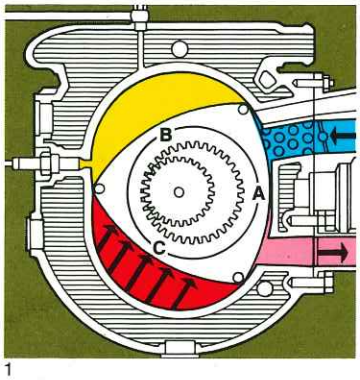
HYDRAULIC COOLANT SYSTEM

The hydraulic oil and coolant are maintained at ambient temperature, enabling the machine to attain more uniform quality of trochoid size and shape.

Gleason machine kinematics for generating the trochoid shape.

ROTARY ENGINE OPERATION

In the rotary combustion engine, the housing remains stationary while the triangular shaped rotor orbits and rotates about the centerline of the crankshaft. As the rotor orbits, it initiates and completes the functions of intake, compression, expansion (power) and exhaust. The apices of the rotor sweep out a two-lobed epitrochoidal curve during this cycle.



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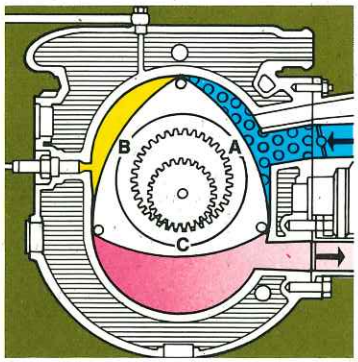

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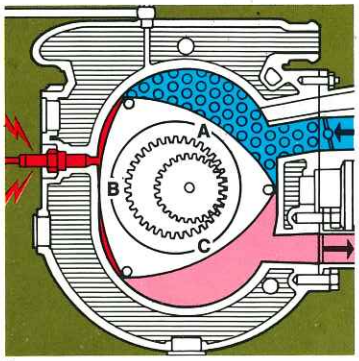

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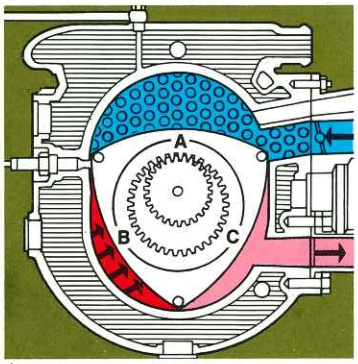

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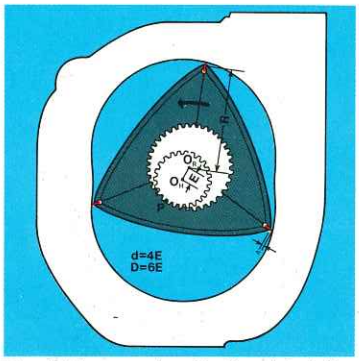
TROCHOID PARAMETERS

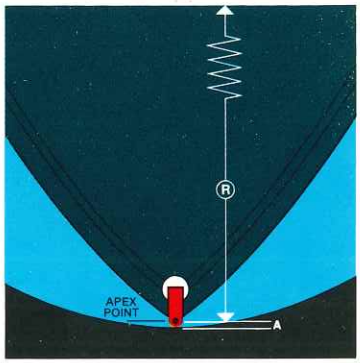
In any given engine, three dimensions completely define the inner shape of the housing. Dimension *E* which is the distance between the center of the fixed gear and the center of the rotor's annular gear. Dimension *R* which is the distance from the geometric center of the rotor to its theoretical apex point. And Dimension *A* which is the seal advance at the tip of the rotor.

CURVE GENERATING SYSTEM

The basic mechanical elements in a rotary combustion engine which define the trochoid shape of its housing include an internal gear which is integral with the triangular rotor, a smaller, stationary gear which mates with the internal gear; and the apices of the rotor. Each apex of the rotor carries a seal with a rounded face that extends beyond the theoretical apex point. The inner surface of the housing is parallel to the curve swept out by the apex points.



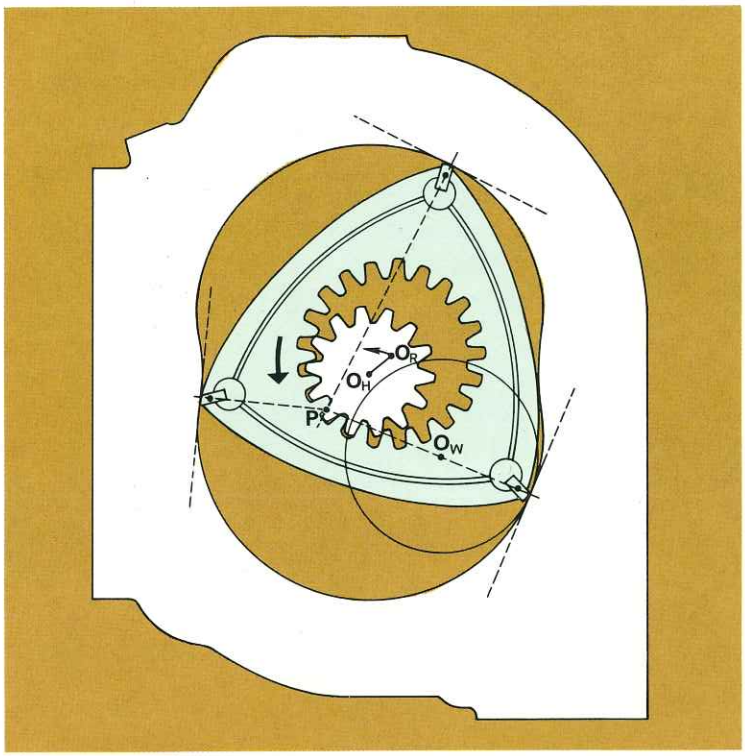
Trochoid parameters E, R and A define the shape of the inner housing surface.



Rotor tip seals extend outward beyond the apex points. Provision for this clearance must be made in machine settings.

MAINTAINING CUTTER TANGENT TO WORK SURFACE.

A line drawn from the instantaneous pitch point of the two gears to an apex of the rotor will be normal to the trochoid surface adjacent to the apex. The cutter carrying element of a generating machine must remain centered on such a normal as the cutter is guided around the inner periphery of the housing. In this way, the cutter face remains tangent to the trochoid surface at all times.



A line drawn from the instantaneous pitch point to a rotor apex is normal to the trochoid.

KINEMATICS APPLIED TO GLEASON MACHINE DESIGN

Gleason Works has developed a curve-generating approach which uses a combination of simple rotary motions to precisely generate the trochoid shape of the engine housing. This approach is based on the concept of an imaginary generating rotor about which the housing moves. (In effect, this is the opposite of what happens in a rotary combustion engine.)

The centerline of the imaginary generating rotor is fixed in position. The housing rotates counter-clockwise about the central axis of the trochoid while the axis simultaneously orbits in a circular path about the fixed axis. The housing rotates at one-half of the velocity at which it orbits. The combination of these motions and velocities achieves correct generation of the desired epitrochoid curve.

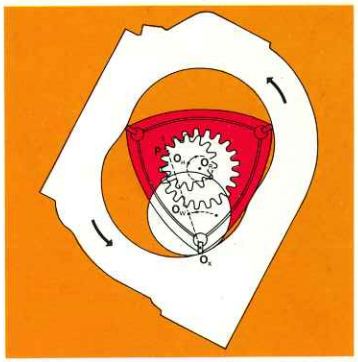
In effect, one apex of the imaginary generating rotor is chosen as the point at which the cutter is to contact the trochoidal surface. A line normal to the curved surface being milled passes through the apex point and pivots on it. The cutter axis remains on the normal line. Therefore, the cutter oscillates about the apex point to maintain the cutter tangent to the curve.

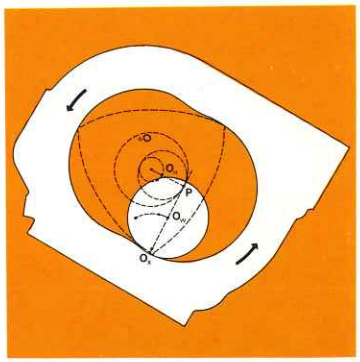
TROCHOID PARAMETERS CONVERTED TO MACHINE SETTINGS

The Gleason kinematic system of generation results in a machine that can accommodate any set of trochoid parameters simply by adjusting four machine settings. Three are directly related to parameters E, R, A mentioned above. A fourth setting is also required to establish the length of the rotating crank for oscillating the arm that supports the tool spindle. This dimension is related to the three other machine settings plus a built-in machine constant.

MODIFICATIONS IN TROCHOID SHAPE

Where a minor modification in portions of the trochoid surface is desired, a shape controlling cam can be provided to move the machine column which carries the wheel. The cam is mounted externally on the machine and turns in conjunction with the work table rotation.



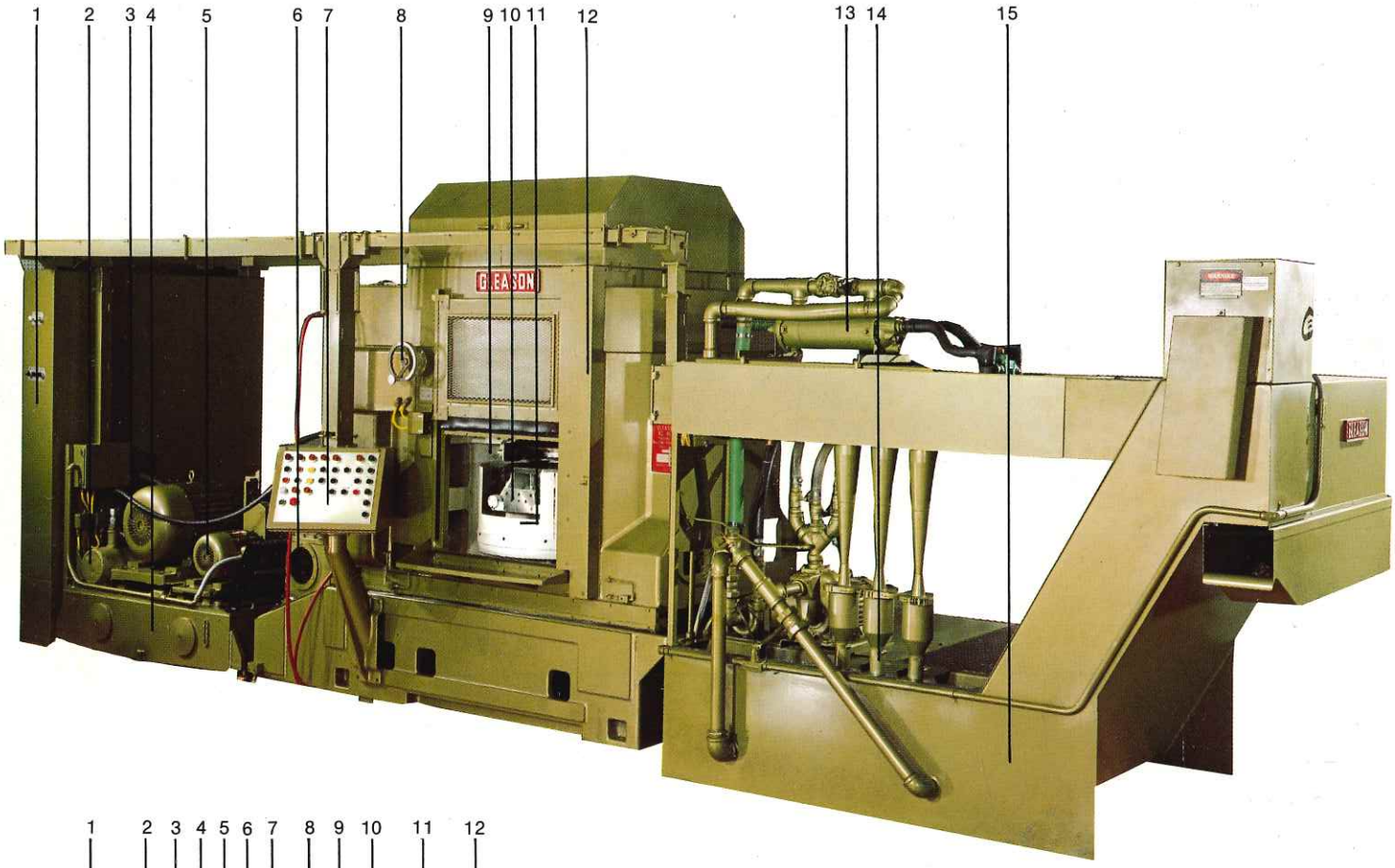


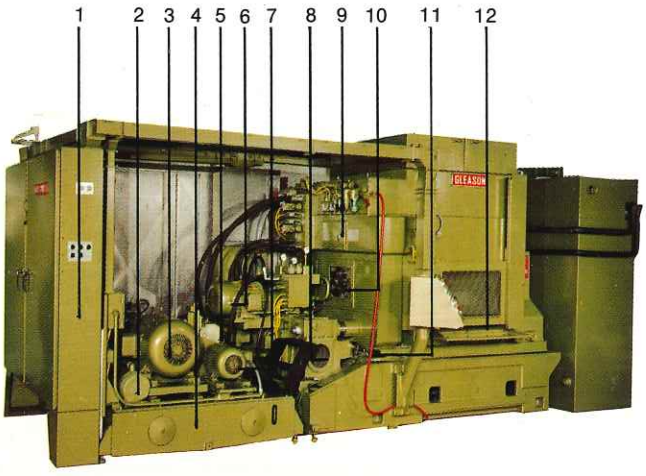
In Gleason Generating Milling Machine, housing rotates and theoretical rotor is stationary. Cutter oscillates about apex point as it traces out trochoid curve.

Gleason No. 807 Trochoid Milling Machine — Features

WORK AREA

1. Electric control box
2. Hydraulic unit heat exchanger
3. Wheel spindle motor
4. Hydraulic unit
5. Lube and hydraulic pump drive
6. Trochoid modification cam
7. Operator control panel
8. Cutter spindle adjustment
9. "A" setting
10. Work holding fixture
11. Work table
12. Column
13. Coolant heat exchanger
14. Chip removal and filtration system
15. Coolant sump





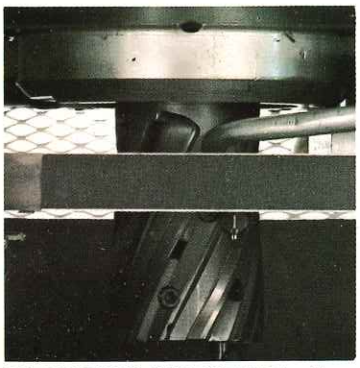
DRIVE SYSTEM AREA

1. Electric control box
2. Hydraulic unit heat exchanger
3. Wheel spindle motor
4. Hydraulic unit
5. Lube and hydraulic pumps
6. Main drive motor
7. Lube and hydraulic pump drive
8. Trochoid modification cam
9. "L" setting
10. Sequence drum
11. "R" setting
12. "E" setting

SEQUENCE OF OPERATION

1. Machine is set up quickly and easily, using four basic settings.
2. Rotor housing is loaded onto work table and automatically clamped into place.
3. Pre-set milling cycle starts. Cutter begins to rotate at pre-determined speed. Cutter is lowered into bore of housing and begins the milling operation. During the milling operation, the work table rotates and orbits the rotor housing relative to the cutter.
4. In addition to these motions, cutter oscillates in a horizontal plane about apex axis to keep cutter tangent to trochoidal curve.
5. As above motions take place, column carrying the cutter is moved relative to frame to feed cutter horizontally into work. This motion controls stock removal.*
6. Upon completion of cycle, cutter feed motion is reset, spindle retracts to its raised position and part is unloaded.

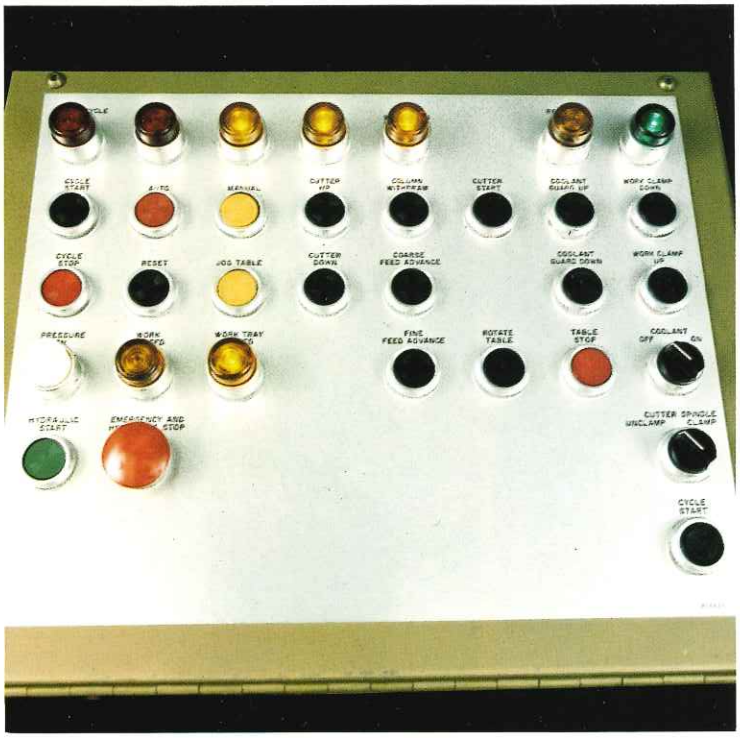
*Note. During cutting cycle, the rate of rotation of the work table can be varied throughout each rotation of the housing to control the peripheral velocity of the bore surface relative to the cutter. This feature optimizes the cutting operation and improves surface finish.

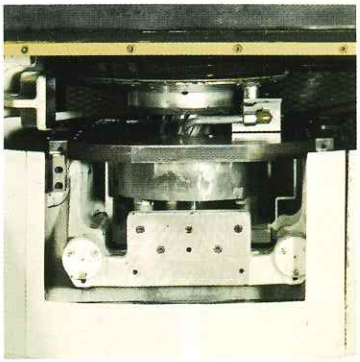


PRECISION MILLING CUTTER is driven by a vertical spindle and oscillated by a rotating overhead crank. This action ensures that the cutter axis always intersects a line normal to the surface being milled, so that the cutter surface is always tangent to the work. Cutter is adjustable from 200 rpm to 3000 rpm to provide optimum results according to the size of the housing and the material being cut.

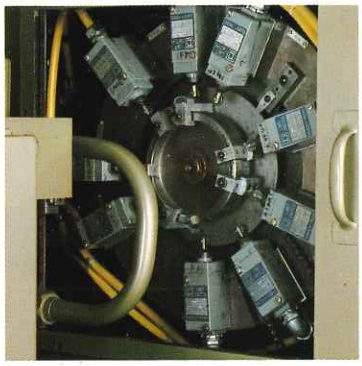
HANDWHEEL is used to advance or withdraw cutter for "A" setting.

OPERATOR CONTROL PANEL IS located adjacent to loading station for operator convenience. Panel includes all major machine functions for setup and for operation.

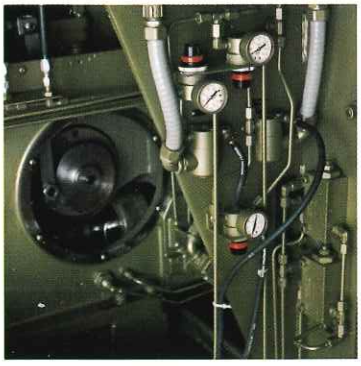




MANUAL OR AUTOMATIC LOADING The configuration of the Gleason No. 807 Trochoid Generating Milling Machine is a significant factor in its suitability to full automation. Work orientation, loading and unloading, hydraulic power clamping, and verification of the part's position in the fixture are all done automatically, if desired.



CYCLE DRUM. Controls the feed displacement of the cutter spindle relative to the work spindle.



ROTATIONAL SPEED CONTROL CAM is easily accessible through cover plate. Rotational speed of workpiece can be varied throughout the 360° cycle to control rate of travel of bore surface past cutter.

ELECTRICAL CONTROL BOX. Some switches and controls are mounted on cabinet at drive end of machine.

No. 807 Cross-Section

MACHINE DRIVE SYSTEM

The Gleason No. 807 Trochoid Generating Milling Machine consists of two large and rigid machine members. The lower frame supports a vertical work spindle and the generating system while the upper member holds a vertical tool spindle and spindle oscillating mechanism.

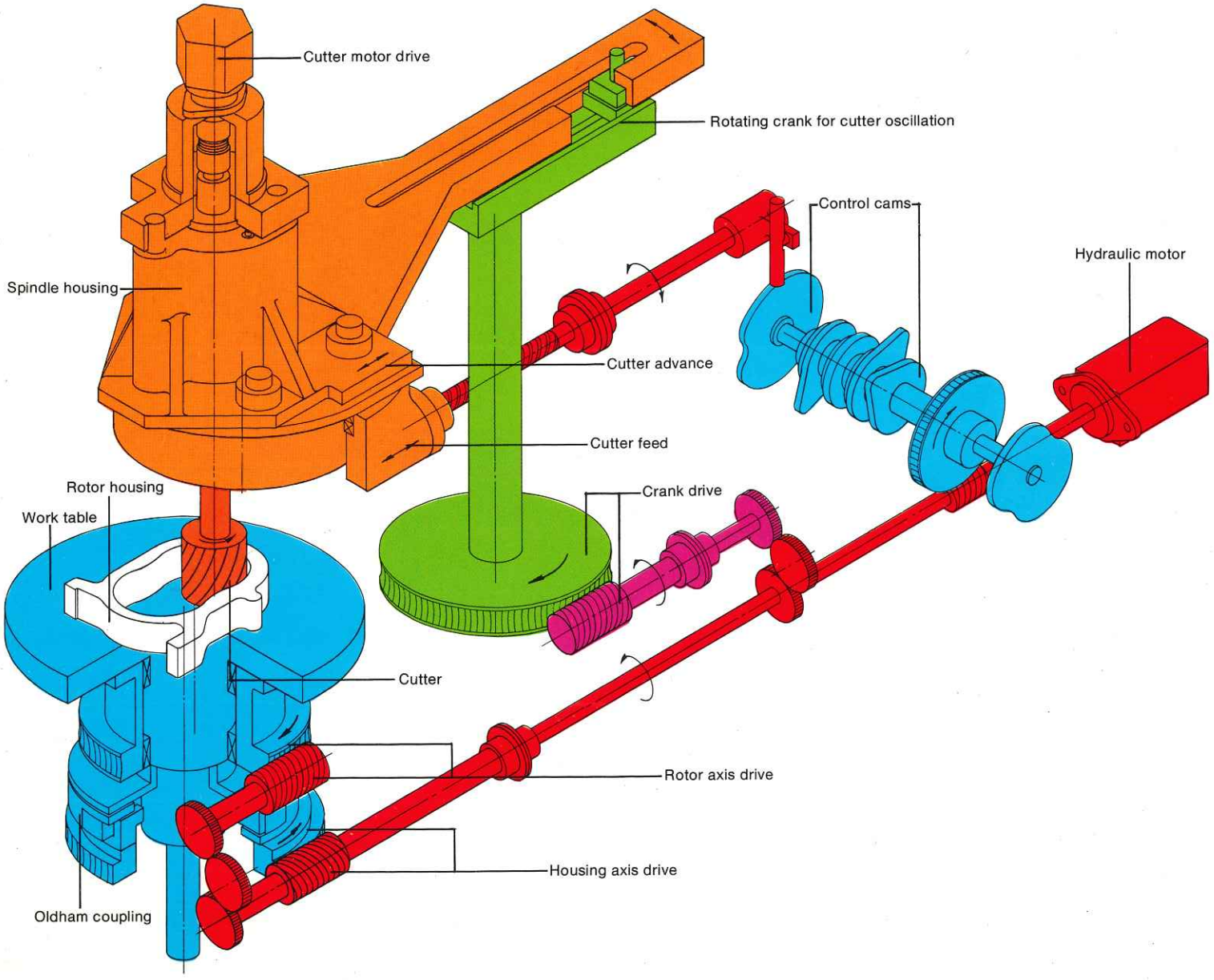
UPPER FRAME MEMBER

The vertical tool spindle drive system is mounted on machine ways and moves laterally for controlling size, for feed motion and to make modifications in the trochoid chamber shape.

The quill-type cutter spindle has anti-friction bearings. It is mounted vertically in an oscillating support in the upper member. The arm attached to the support engages a rotating pin driver journaled in the upper frame. The cutter is movable in the direction of the arm to position it (Distance A) relative to the axis of oscillation through the apex of the imaginary generating rotor.

LOWER FRAME

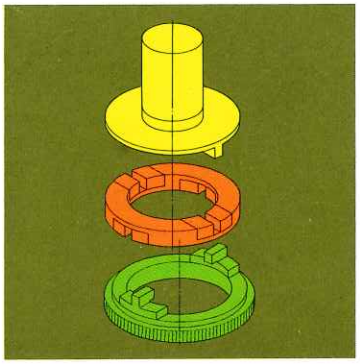
In the lower section, the worktable with its workholding fixture carries the rotor housing. The workpiece has two motions applied to it: clockwise orbiting about the fixed rotor axis, and counterclockwise rotation about the central axis of the trochoid. The generating



system incorporates two large worm gear drives which simulate the motions that would be produced by a small external gear engaging with the internal gear of the imaginary generating rotor.

OLDHAM COUPLING

The lower worm gear is connected to the rotating work spindle by means of an Oldham coupling. (The Oldham coupling is a mechanical coupling containing a cross key member with one keyway on the bottom half and another at right angles to it in the upper half.) A tailpiece extending down through the Oldham coupling provides a route for hydraulic pressure that actuates the workholding equipment on the table and also carries air for the seating inspection mechanism.



VARIABLE WORK ROTATIONAL SPEED

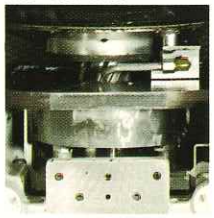
The rotational speed of the workpiece can be varied throughout the 360° cycle to control the rate of travel of the bore surface past the cutter for optimum stock removal rates and smooth finish along each portion of the trochoid.

MACHINE SETTINGS

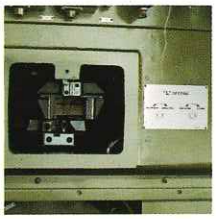
Four simple machine settings enable operator to machine any size rotor housing being produced in large quantities today.

Setting A = apex seal radius. Obtained by positioning the outside diameter of the cutter relative to the apex axis.

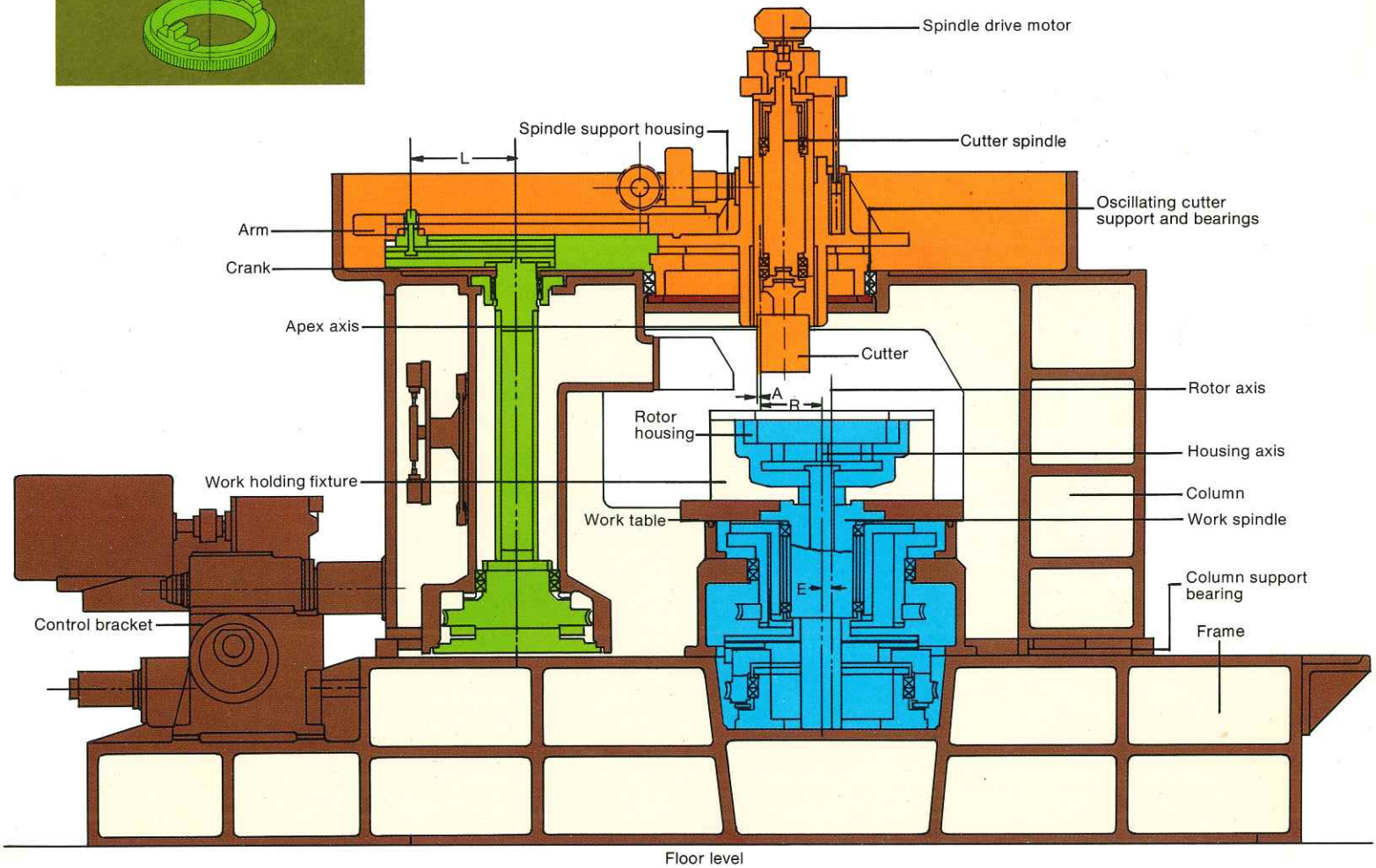
Setting E = engine crank length. Setting is obtained by shifting the work spindle relative to the rotor axis.



Setting L = crank length. This is a machine setting proportional to E/R and determines the amount of cutter oscillation angle.



Setting R = radius of engine rotor. This machine setting is obtained by moving the column horizontally on its hydrostatic support surfaces, and is equal to the distance between the apex axis and the rotor axis.



Specifications—No. 807 Trochoid Generating Milling Machine

STANDARD EQUIPMENT

- Automatic feed and size control.
- Arrangement for variable rate of work rotation for one part.
- Adjustable cutter speed drive.
- Automatic guards.
- Arrangement with connections for central coolant supply system.
- Complete electrical equipment with motors, controls, and installation for three-phase, 50 or 60 cycle alternating current.

EXTRA EQUIPMENT

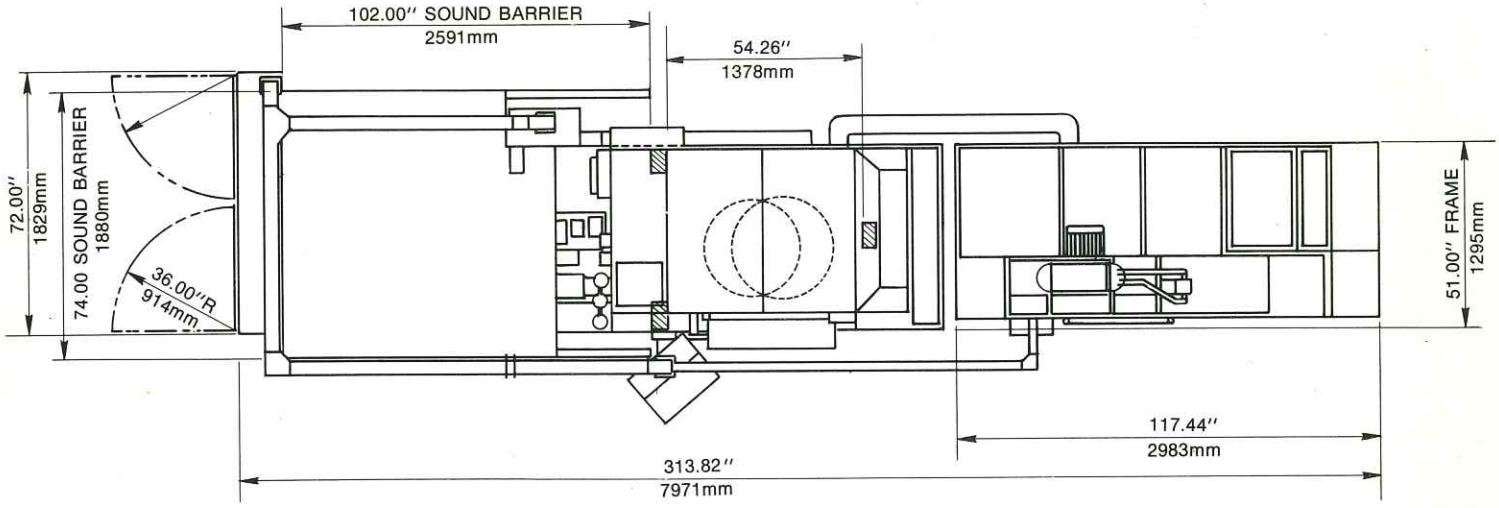
- Positive type coolant filtration system in place of central supply system.
- Refrigeration system for both coolant and hydraulic systems in place of central supply system.
- Manual loader with automatic work clamping fixture for one size rotor housing.
- Automatic loader for one size rotor housing.
- Arrange loader with load and unload storage magazines for one size rotor housing.
- Arrange machine for trochoid modification (less cam).
- Trochoid modification cam.
- Additional work rotation control cam.
- Setup gage for cutter.
- Workholding fixture handling equipment.
- Arrange machine for milling ferrous parts in place of aluminum (provides low speed spindle and drive system).
- Machine setting bars.
- Sound barrier enclosure

MACHINE CAPACITY	ENGLISH	METRIC
Rotor apex radius (R)	0-7.40 "	0-18.80 cm
Crankshaft eccentricity (E)	0-1.00 "	0- 2.54 cm
Apex seal offset (A)	0-0.300"	0- 0.76 cm
Maximum rotor housing thickness	3.5"	8.89 cm
Wheel feed advance and withdraw	0-0.250"	0- 0.64 cm
Trochoid surface modification	0-0.010"	0- 0.025 cm
Largest major diameter	16.0"	40.64 cm
Specifications exceeding above should be reviewed.		
CUTTER SPINDLE		
Minimum O.D. of cutter	2.5"	6.35 cm
Maximum O.D. of cutter	4"	10.2 cm
Cutter rpm	FERROUS	ALUMINUM
Minimum	200 rpm	1500 rpm
Maximum	700 rpm	3000 rpm
Smaller cutter diameters and higher spindle speeds are available as special items.		
HOUSING TABLE	FERROUS	ALUMINUM
Table rpm Minimum	0.25 rpm	2.5 rpm
Maximum	5 rpm	15 rpm
Table O.D.	27"	
MOTORS		
Cutter spindle drive pump	25 hp	
Machine drive pump	7.5 hp	
Coolant unit	5.25 hp	
Hydraulic system	3 hp	
MISCELLANEOUS		
Machine weight (est.)	30,000 lbs.	13,600 Kgs.
Length	112"	284.5 cm
Width	51"	129.5 cm
Height —to quill cover (closed)	105"	266.7 cm
—to quill cover (open)	119"	302.3 cm

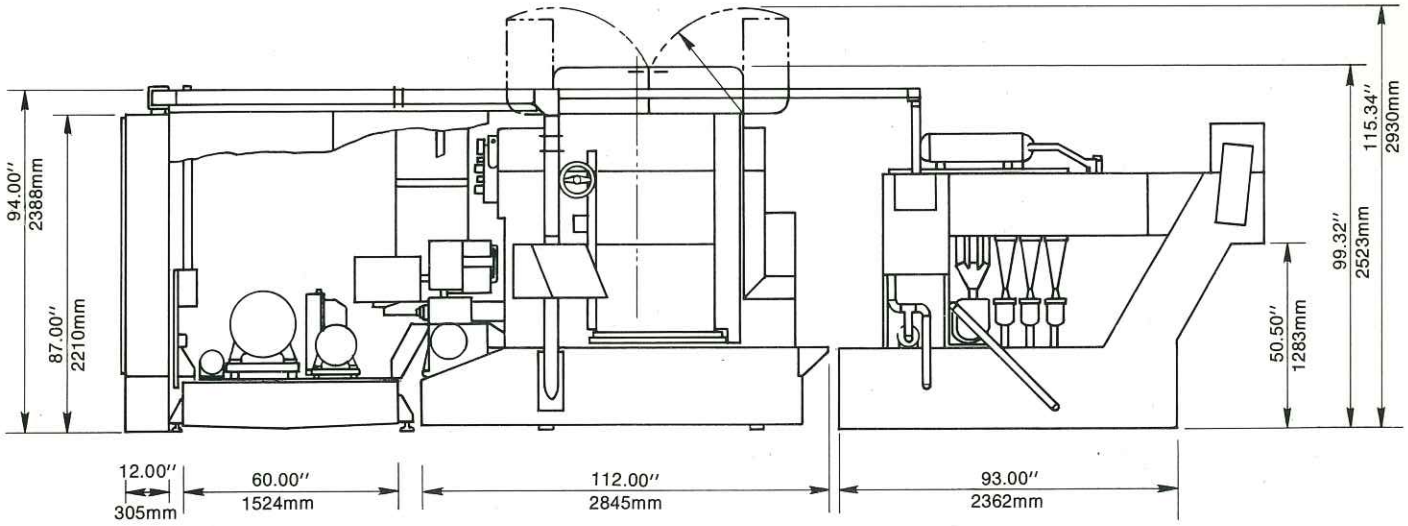
NOTE: Cutters are quoted upon receipt of prints. Arranging loaders for an additional part quoted on application.

Dimensions—No. 807 Trochoid Generating Milling Machine

Top View



Side View



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